DPSCM 4155.12

FOREWORD
(Supplementation is prohibited.)

This Manual is published by the Defense Personnel Support Center (DPSC) for use by Government personnel assigned to DPSC subsistence contract monitoring.

This Manual will be maintained in a current status and reviewed annually.

Users of this publication are encouraged to submit recommended changes and comments to improve the publication, through channels, to Directorate of Subsistence, ATTN: DPSC-HQP.

BY ORDER OF THE COMMANDER

LEONARD N. AQUILINO
Ch, Administrative Services Div
Office of Installation Services

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This DPSC Manual supersedes DPSC Manual 4155.12, 1 Jun 82, and Change No. 1.
* Denotes Changes.

TABLE OF CONTENTS

I. REFERENCES.

A. Listed ASTM Publications are published by the American Society For Testing and Materials, 1916 Race St., Philadelphia, PA 19103.

l. ASTM Fixed Designation E 29, Recommended Practice for Indicating Which Places of Figures Are To Be Considered Significant In Specified Limiting Values.

2. ASTM Fixed Designation E 380, Standard for Metric Practice (a guide to the use of SI - The International System of Units).

3. ASTM STP 15C, ASTM Manual on Quality Control of Materials.

B. Handbook of Chemistry and Physics, 62nd Ed., 1981-1982, the Chemical Rubber Co., Cleveland, OH 44128.

C. Metric Editorial Guide, ANMC-78 (DoD Acceptance Notice - Project Number MISC-0C08).

II. PURPOSE AND SCOPE. The purpose of this Manual is to provide material relevant to expression of numerical values, whether observed or calculated.

III. DEFINITIONS.

A. Digit-or-Figure. Any one of the ten Arabic numerals 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, by which all numbers are expressed in our system of notation.

B. Mathematical Signs and Symbols 10n Powers of 10, exponential value (superscript) indicates number of iterations (multiplications). Negative exponent changes the term to its reciprocal, i.e.,

$10^{n} = \frac{1}{10^{n}}$

x Absolute value of enclosed quantity, value regardless of its sign.

n nth root. Index is omitted in case of square root.

X Arithmetic Avg. value of X, read XBar.

+	Plus or minus.	Sum of.
	Proportional to.	Less than.
	Greater than.	Less than or equal to.
	Greater than or equal to.	Not less than.
	Not greater than.	Not equal to.
	Approximately equal to.	Identically equal to.

C. Number. A digit or series of digits used in arranging or classifying quantities.

D. Place. The position of a digit in relation to the decimal point. Multiples of any unit quantity are positioned to the left, and subdivisions or fractions of any unit quantity are positioned to the right of the decimal point.

Location and Designation of Place from the Decimal Point

13(12)11(10)987654321 . 123456789(10) 11(12)13

In the International System of Units (SI), place is designated by powers of 10, especially for values in or greater than thousands and for values in or less than thousandths. The power, expressed as an exponent of 10 is positive, or unsigned, for multiples of unity, and negative, i.e., with a minus sign, for subdivisions of unity.

Table I SI Unit Prefixes

Multiplication Factor	Prefix	Symbol	Customary Term
1 000 000 000 000 = 1012	tera	T	one trillion
1 000 000 000 = 109	giga	G	one billion
1 000 000 = 106	mega	M	one million
1 000 = 103	kilo	k	one thousand
100 = 102	hecto	h	one hundred
10 = 10	deka	da	ten
0.1 = 101	deci	d	one tenth
0.01 = 102	centi	c	one hundredth
0.001 = 103	milli	m	one thousandth
0.000 001 = 106	micro	u	one millionth
0.000 000 001 = 109	nano	n	one billionth
0.000 000 000 001 = 1012	pico	p	one trillionth

E. Scale. A series of marks along a line, at regular or graduated distances, used in measuring or computing: as, the scale of a thermometer.

F. Significant Digits. The digits that indicate the extent to which the number is accurate. Unless the computations so indicate, zeros after a whole number and zeros immediately following a decimal point are not significant digits. See examples in paragraph VI.C.

IV. BACKGROUND.

A. Numbers involved in conducting tests and examinations, or in determining compliance of a sampled item in accordance with the applicable specification or other contract requirement, are either count values or measurement values. Count values can be significant to as many digits as result from the items counted and are discrete whole number values that are subject to error from not counting items that should be counted. Measurement values are significant to as many digits as the calibrations of the measuring device represent, subjected to the reading or estimation of the person making the measurement. They are values from a continuous scale subject to errors of estimation of the point value along the continuous scale. Hence, the accuracy of an observed measurement, on a scale calibrated in whatever increments of a measuring unit, is affected by the location of the indicator in relation to two adjacent scale marks and the number of smaller divisions estimated between the numerically lower value increment mark and the indicator.

B. Observed measurements, as well as calculated values based on counts and measurements, usually require rounding off so that accuracy is not exaggerated nor sacrificed. The calculations frequently utilize conversion factors, mathematical formulas, and other quantified information that affect the length or shortness, i.e., the number of places of the results. To ensure consistency in making observations and computations involving observations of a measurement, the procedures of this Manual will be used unless otherwise indicated in the document concerned with the involved data. It should be noted that most specifications stipulate that measurements are to be reported to a finer increment than that in which the requirement is stated. This is to assure that an adequate scale is used and to reveal trends, especially borderline trends due to particular plant manufacturing or processing controls of advanced technology that better the industry's general performance. Such information is of value in specification review work.

C. Following is the general practice of scientific, technical and industrial groups:

1. The exponents "2" and "3" are used to indicate "square" and "cubic" respectively, instead of the abbreviations "sq" or "cu" however frequent their use for the U.S. customary units.

2. Periods are not used after abbreviations unless the abbreviation spells a word and is not written in upper case.

3. The digits of numbers having four or more digits should be placed in groups of three separated by a space instead of commas counting both to the left and to the right of the decimal point.

V. RESPONSIBILITIES. The Product Quality Branch (DPSC-HQP) is responsible for maintaining this publication in a current status and reviewing it annually.

VI. PROCEDURES FOR ROUNDING OFF AND RETENTION OF NUMBERS.

A. Dropping or rounding numbers should be done after computations are completed in order to minimize the possibility of computation errors in the final result. In dropping or rounding numbers, only the first two digits immediately following the digit to be retained shall be considered and rounding shall be executed in one step. See Table 2.

1. If the first digit to be dropped is less than 5, the last digit retained shall be left unchanged.
2. If the first digit to be dropped is more than 5 or is a 5 followed by a digit greater than 0, the last digit retained shall be increased by 1.
3. If the first digit to be dropped is a 5 alone or a 5 followed immediately by 0 and the last digit retained is:
   a. Odd (1, 3, 5, 7 or 9) it shall be increased by 1.
   b. Even (0, 2, 4, 6 or 8) it shall be left unchanged.

Table 2

Examples of Rounding and Attendant Conformance Decisions

	Observed Value or Calculated	To be Rounded	Rounded Value to be Used for Determining Conformance	Conforms to Requirement
29g< Wt< 35g	35.4	1 Gram	35	Yes
	35.5	1 Gram	36	No
Not More Than 22%	21.50	1%	22	Yes
	21.49	1%	21	Yes
	22.50	1%	22	Yes
	22.51	1%	23	No
Marked Net Wt to Nearest Quarter Pound (Weigh to Nearest One Eighth Pound)	45.00	Quarter Pound	45.00	Yes
	44.875	Quarter Pound	45.00	Yes
	44.75	Quarter Pound	44.75	Yes
	44.625	Quarter Pound	44.50	Yes

B. Wherever possible in presenting the results of computations on a set of two or more numbers, retain a minimum of two more places of significant digits (the digits that indicate the extent to which the number is accurate) than those in the single observed number of largest value. This generalization is an attempted synthesis of the following guidelines for specific mathematical processes which provide results least prone to rounding error:

1. In addition and subtraction, the answer shall contain no significant digit farther to the right than occurs in the least accurate figure.

2. In multiplication and division, the product or quotient shall contain no more significant digits than are contained in the number with the fewest significant digits used in the multiplication or division. The difference between this statement and the statement for addition and subtraction should be noted. The addition and subtraction statement merely requires rounding off digits that lie to the right of the last significant digit in the least accurate number.

C. Examples:

1. Zero is not a significant digit:

5 x 11 inches = 55 inches, not 55.00 inches. 55.00 inches is improperly stated. The zeros immediately after the decimal point are not significant because the data indicates accuracy only to the whole inch. The actual value lies between 54.6 and 55.4. 0.003 8 g/mL has two significant digits, 38, as the zeros immediately after the decimal point merely identify the place (see subparagraph III.D.) occupied by the significant digits. The actual value lies between 0.003 75 and 0.003 85.

Standard plate count of 24 000 colonies/mL has two significant digits, 24. The zeros after the whole number merely identify the place occupied by the significant digits. Since colonies vary in size, attempts at greater accuracy are not feasible. The actual value lies between 23 500 and 24 500.

2. Zero is a significant digit:

5 x 12 inches = 60 inches. The zero after the whole number is a significant digit because the data indicates accuracy to the whole inch. The actual value lies between 59.5 and 60.5.0.003 80 g/mL has three significant digits, 380. The zeros immediately after the decimal point are not significant (see example 1) but the zero after the 8 is significant because it does not follow a whole number, nor immediately follow a decimal point. The actual value is between 0.003 795 and 0.003 805.

3. Specific Mathematical Processes (see subparagraphs VI.B.1 and VI.B.2).

Addition:	105.3 + 2.64 = 107.94 and rounds to 107.9
Subtraction:	105.3 2.64 = 102.66 and rounds to 102.7
Multiplication:	105.3 x 2.64 = 277.992 and rounds to 278
Division:	105.3 / 2.64 = 39.886 and rounds to 39.9

(Note that rounded answers to addition and subtraction processes contain the same number of significant digits (4) as the least accurate number processed. The rounded answers to the multiplication and division processes contain the same number of significant digits (3) as in the number processed having the fewest significant digits, regardless of the accuracy of that number.)

D. Whenever conformance with an average requirement is determined by application of a recognized statistical test, reports shall be annotated to identify the test applied.

VII. MISCELLANEOUS EQUIVALENTS, CONVERSION FACTORS, AND EXAMPLES OF CALCULATIONS.

A. Tables.

Table 3
Equivalents and Conversion Factors for U.S. and Metric Measures

To Convert From	Multiply By	To Derive
Bushel (bu)	1.2445	cubic feet (ft3)
"	3.524 x 102	cubic meters (m3)
"	8 gallons, dry (gal)	
"	9.309 2 gallons, fluid (gal)	
"	3.524 liters (L)	
Centimeters (cm)	3.281 x 102	feet (ft)
Centimeters (cm)	3.937 x 101	inches (in.)
Centimeters (cm)	1.000 x 102	meters (m)
Cubic Feet (ft3)	2.832 x 102	cubic meters (m3)

Table 3 (Cont'd)

To Convert From	Multiply By	To Derive
Cubic Feet (ft3)	6.428 5	gallon, dry (gal)
Cubic Feet (ft3)	7.480 5	gallons, fluid (gal)
Cubic Feet of Water (Maximum Density) at 39.2oF (3.98°C)	2.832 x 101	kilograms (kg)
Cubic Feet of Water (Maximum Density) at 39.2oF (3.98°C)	6.243 x 101	pounds (lb)
Cubic Feet of Water at 71.6oF (22°C)	2.822 x 101	kilograms (kg)
"	6.222 x 101	pounds (lb)
Cubic Inches (in3)	5.787 x 104	cubic feet (ft3)
"	1.639 x 105	cubic meters (m3)
"	1.639 x 102	liters (L)
Cubic Inches (in3)	1.488 x 102	quarts, dry (qt)
"	1.732 x 102	quarts, fluid (qt)
Degrees Celsius (centigrade) (°C)	1.8 and add 32	degrees Fahrenheit (°F)
Degrees Fahrenheit (°F), subtract 32 and	0.556	degrees Celsius (centigrade) (°C)
Feet (ft)	3.048 x 101	meters (m)
Gallons, Dry (gal)	2.688 x 102	cubic inches (in3)
Gallons, Dry (gal)	4.405 x 103	cubic meters (m3)
Gallons, Fluid (gal)	2.31 x 102	cubic inches (in3)
"	3.785 x 103	cubic meters (m3)
Gallons of Water (Maximum Density) at 39.2°F (3.98°C)	3.785	kilograms (kg)
"	8.345	pounds (lb)
Gallons of Water at 71.6°F (22°C)	3.773	kilograms (kg)

Table 3 (Cont'd)

To Convert From	Multiply By	To Derive
Gallons of Water at 62oF (22^{o}C)	8.3356	pounds (lb)
Grams (g)	3.527 x 102	ounces, avoirdupois (oz)
"	2.205 x 103	pounds (lb)
Inches (in)	2.540	centimeters (cm)
Liters (L)	6.103 x 101	cubic inches (in3)
"	2.270 x 101	gallons, dry (gal)
Liters (L)	2.642 x 101	gallons, fluid (gal)
"	3.381 x 101	ounces, fluid (oz)
Meters (m)	3.281	feet (ft)
Meters (m)	3.937 X 101	inches (in)
Milliliters (mL)	6.103 x 102	cubic inches (in3)
"	3.381 x 102	ounces, fluid (oz)
Ounces, avoirdupois (oz)	2.835 x 101	grams (g)
"	" 6.250 x 102	pounds (lb)
Ounces, Fluid (oz)	1.80 5	cubic inches (in3)
Ounces, Fluid (oz)	7.812 x 103	gallon, fluid (gal)
"	2.957 x 102	liters (L)
Pecks (pk)	3.111 x 101	cubic feet (ft3)
Pecks (pk)	5.376 x 102	cubic inches (in3)
"	2	gallons, dry (gal)
"	2.327	gallons, fluid (gal)
Pecks (pk)	8.81	liters (L)
Pounds, avoirdupois (lb)	4.536 x 102	grams (g)
Quart, dry (qt)	3.125 x 102	bushels (bu)
Quart, Dry (qt)	3.889 x 102	cubic feet (ft3)
"	6.720 x 101	cubic inches (in3)
"	1.101	liters (L)
Quart, fluid (qt)	5.775 x 101	cubic inches (in3)
"	9.463 x 101	liters (L)

Table 4
Decimal Equivalents of Common Fractions

3rds	4ths	5ths	6ths	8ths	12ths	16ths	20ths	32nds	64ths	Decimal Equivalent
									1/64	.015 625
								1/32	2/64	.031 250
									3/64	.046 875
							1/20			.050 000
						1/16	2/32	4/64		.062 500
									5/64	.078 125
					1/12					.083 333
								3/32	6/64	.093 750
							2/20			.100 000
									7/64	.109 375
				1/8	2/16	4/32	8/64			.125 000
									9/64	.140 625
							3/20			.150 000
								5/32	10/64	.156 250
			1/6		2/12					.166 667
									11/64	.171 875
				3/16	6/32	12/64				.187 500
							1/5	4/20		.200 000
									13/64	.203 125
								7/32	14/64	.218 750
									15/64	.234 375
		1/4	2/8	3/12	4/16	5/20	8/32	16/64		.250 000
									17/64	.265 625
								9/32	18/64	.281 250
									19/64	.296 875
							6/20			.300 000
				5/16	10/32	20/64				.312 500
									21/64	.328 125
			1/3	2/6	4/12					.333 333
								11/32	22/64	.343 750
							7/20			.350 000
									23/64	.359 375
				3/8	6/16	12/32	24/64			.375 000
									25/64	.390 625
							8/20	2/5		.400 000
								13/32	26/64	.406 250
					4/12	8/16	16/32			.416 667
									27/64	.421 875

Table 4 (Cont'd)
Decimal Equivalents of Common Fractions

3rds	4ths	5ths	6ths	8ths	12ths	16ths	20ths	32nds	64ths	Decimal Equivalent
									7/16--14/3228/64	.437 500
									9/20-	.450 000
									29/64	.453 125
									15/3230/64	.468 750
									31/64	.484 375
									2/4---3/64/8-6/128/1610/2016/3232/64	.500 000
									33/64	.515 625
									17/3234/64	.531 250
									35/64	.546 875
									11/20-	.550 000
									9/1618/3236/64	.562 500
									37/64	.578 125
									7/12-	.583 333
									19/3238/64	.593 750
									3/512/20	.600 000
									39/64	.609 375
									5/810/1620/3240/64	.625 000
									41/64	.640 625
									13/20	.650 000
									21/3242/64	.656 250
									2/34/68/12	.666 667
									43/64	.671 875
									11/1622/3244/64	.687 500
									14/20	.700 000
									45/64	.703 125
									23/3246/64	.718 750
									47/64	.734 375
									3/4-6/89/1212/1615/2024/3248/64	.750 000
									49/64	.765 625
									25/3250/64	.781 250
									51/64	.796 875
									4/516/20-	.800 000
									13/1626/3252/64	.812 500
									53/64	.828 125
									5/610/12-	.833 333
									27/3254/64	.843 750
									17/20	.850 000

Table 4 (Cont'd)
Decimal Equivalents of Common Fractions

3rds	4ths	5ths	6ths	8ths	12ths	16ths	20ths	32nds	64ths	Decimal Equivalent
									55/64	.859 375
						7/8	14/16	28/32	56/64	.875 000
									57/64	.890 625
							18/20			.900 000
								29/32	58/64	.906 250
					11/12-					.916 667
									59/64	.921 875
						15/16-	30/32	60/64		.937 500
							19/20			.950 000
									61/64	.953 125
								31/32	62/64	.968 250
									63/64	.984 375
3/3-	4/4-	5/5	6/6	8/8	12/12	16/16	20/20	32/32	64/64	1.000 000

B. Can Sizes in Inches.

Can makers' descriptions give diameter followed by the height. The first digit of each group represents inches and the second and third digits represent sixteenths of an inch. Examples:

307 x 704 is a can 3-7/16 inches in diameter by 7-4/16 inches high.

603 x 700 is a can 6-3/16 inches in diameter by 7 inches high.

C. Examples:

Volume of a rectangular container = length x width x height (L X W X H).

1. According to MILSTD129, the volume of shipping containers is to be marked to the nearest tenth of a cubic foot. Shipping containers to which this applies measure 16-1/2 in. x 12-7/16 in. x 11-5/8 in. Hence, using Table 4, Decimal Equivalents:

Volume = 16.5 in. x 12.437 5 in. x 11.625 in. = 2 385.668 in3, and using Table 3, Conversion Factor (5.787 x 104 ft3/in3) to derive cubic feet:

2 385.668 in3 x 0.000 578 7 ft3/in3 = 1.381 ft3.

Rounding in accordance with the requirement for the nearest tenth of a cubic foot:

1.381 ft3 1.4 ft3

2. A NATO contract calls for marking the volume of shipping containers to the nearest hundredth of a cubic meter. Proceed as in example C.1 above to calculate the volume in cubic inches. Then, using Table 3, Conversion Factor, (1.639 x 105 m3/in3) to derive cubic meters (assuming containers measure as in example C.1. above):

2 385.668 in3 x 0.000 016 39 m3/in3 = 0.039 101 m3.

Rounding in accordance with the requirement for the nearest hundredth of a cubic meter:

0.039 101 m3 0.04m3

3. The volume of a palletized load depends on the largest area of the course or pallet and the overall height of all courses in the load plus the height of the pallet. Suppose in the illustration indicated below, the following dimensions were measured:

a. Pallet length = 40 in.
b. Pallet width = 48 in.
c. Pallet height = 5 in.
d. Overall length of all courses in the load = 41-3/8 in.
e. Overall width of all courses in the load = 49-3/4 in.
f. Overall height of all courses in the load = 34-7/8 in.

Then the volume of the palletized load = maximum length X maximum width X maximum height:

= (d) X (e) X (c) + (f)
= 41-3/8 in. X 49-3/4 in. X 5 in. + 34-7/8 in.
= 41-3/8 in. X 49-3/4 in. X 39-7/8 in.
= 41.375 in. X 49.75 in. X 39.875 in.
= 82 078.949 in.3.

Converting to cubic feet, 82 078.949 in.3 X 0.000 578 7 ft3/in3 = 47.499 ft3.

Rounding in accordance with the requirement for the nearest tenth of a cubic foot:

47.499 ft3 47.5 ft3

4. Should a NATO contract be involved, calculations would precede as above through determining the volume in cubic inches, then converting to cubic meters:

Volume in cubic meters = 82 078.949 in3 x 0.000 016 39 m3/in3 = 1.345 273 m3.

Rounding in accordance with the requirement for the nearest hundredth of a cubic meter:

1.345 273 m3 1.35 m3

CH 1
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7 SEP 84

CHANGE NO. 1
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SUBSISTENCE COMPUTATION GUIDE

I. DPSCM 4155.12, 1 Jun 82, is changed as follows:
Remove pages listed below and insert revised pages. Changes are indicated by marginal asterisks.

Remove Old	Insert New
FOREWORD 3 and 4	FOREWORD 3 and 4

II. This change sheet will be filed in front of the publication for reference purposes after changes have been made.

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I. DPSCM 4155.12, 1 Jun 82, and Change 1, 7 Sep 84, are cancelled. Guidance is provided in documents referenced in paragraph I of basic Manual.

II. This notice will be retained for reference purposes in place of cancelled publication.

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